

The documentation and process conversion measures necessary to comply with this revision shall be completed by 29 December 1994

INCH-POUND

MIL-S-19500/512B
29 September 1994
SUPERSEDING
MIL-S-19500/512A
8 June 1987

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON
SWITCHING TYPES 2N4029, 2N4033
JAN, JANTX, JANTXV, AND JANS

This specification is approved for use by use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for PNP, silicon transistors designed for use in high speed switching and driver applications. Four levels of product assurance are provided for each device type as specified in MIL-S-19500.

1.2 Physical dimensions. See figures 1 and 2 (TO-18 and TO-39).

1.3 Maximum ratings.

P _T T _A = +25°C		V _{CB0}	V _{CE0}	V _{EB0}	I _C	T _{0P} and T _{STG}
2N4029	2N4033					
<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>°C</u>
0.5 1/	0.8 2/	80	80	5	1.0	-55 to +200

1/ Derate at 2.86 mW/°C above T_A = 25°C.

2/ Derate at 4.56 mW/°C above T_A = 25°C.

1.4 Primary electrical characteristics at T_A = 25°C.

	h _{FE1}	h _{FE2}	h _{FE3}	h _{FE4}
LIMITS	V _{CE} = 5.0 V dc I _C = 100 μA dc	V _{CE} = 5.0 V dc I _C = 100 mA dc	V _{CE} = 5.0 V dc I _C = 500 mA dc	V _{CE} = 5.0 V dc I _C = 1.0 mA dc
MIN	50	100	70	25
MAX		300		

	h _{fe}	V _{CE(sat)} 2	C _{obo}	t _d	t _r	t _s	t _f
LIMITS	V _{CE} = 10 V dc I _C = 50 mA dc f = 100 MHz	I _C = 500 mA dc I _B = 50 mA dc	V _{CB} = 10 V dc I _E = 0 100 kHz < f < 1 MHz				
MIN	1.5	<u>V dc</u>	<u>pF</u>	<u>ns</u>	<u>ns</u>	<u>ns</u>	<u>ns</u>
MAX	6.0	0.5	20	15	25	175	35

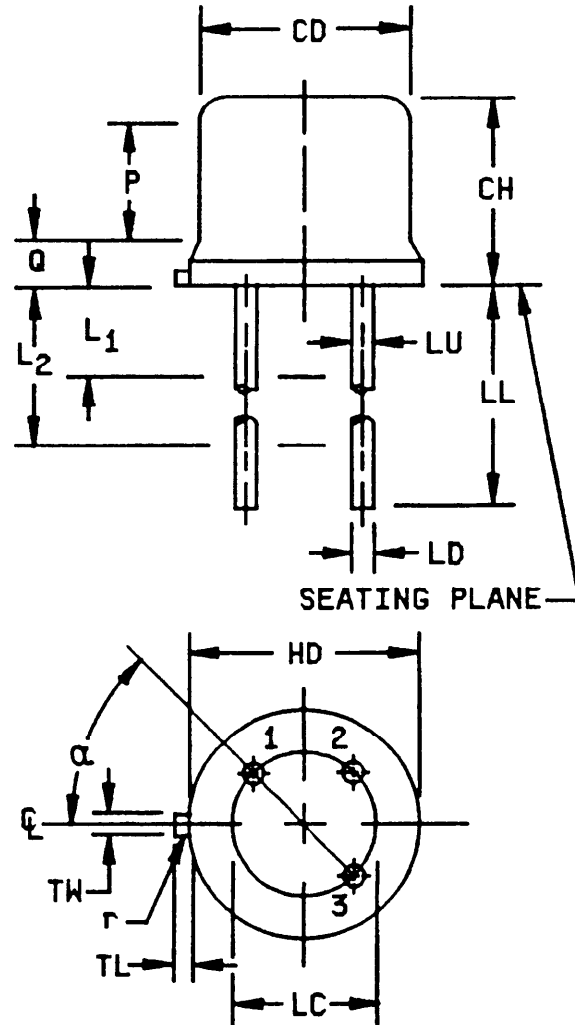
Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: NASA/Parts Projects Office (NPPPO), NASA Goddard Space Flight Center, Code 310.A, Greenbelt, MD 20771 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 5961

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

Symbol	Inches		Millimeters		Note
	Min	Max	Min	Max	
CD	.178	.195	4.52	4.95	4
CH	.170	.210	4.43	5.33	
HD	.209	.230	5.31	5.84	
LC	.100 TP		2.54 TP		5
LD	.016	.021	0.41	0.53	6
LL	.500	.750	12.70	19.05	
LU	.016	.019	0.41	0.48	6
L ₁		.050		1.27	6
L ₂	.250		6.35		6
TL	.028	.048	0.71	1.22	
TW	.036	.046	0.91	1.17	
P	.100		2.54		
Q		.040		1.02	
r		.010		0.18	10
a	45° TP		45° TP		

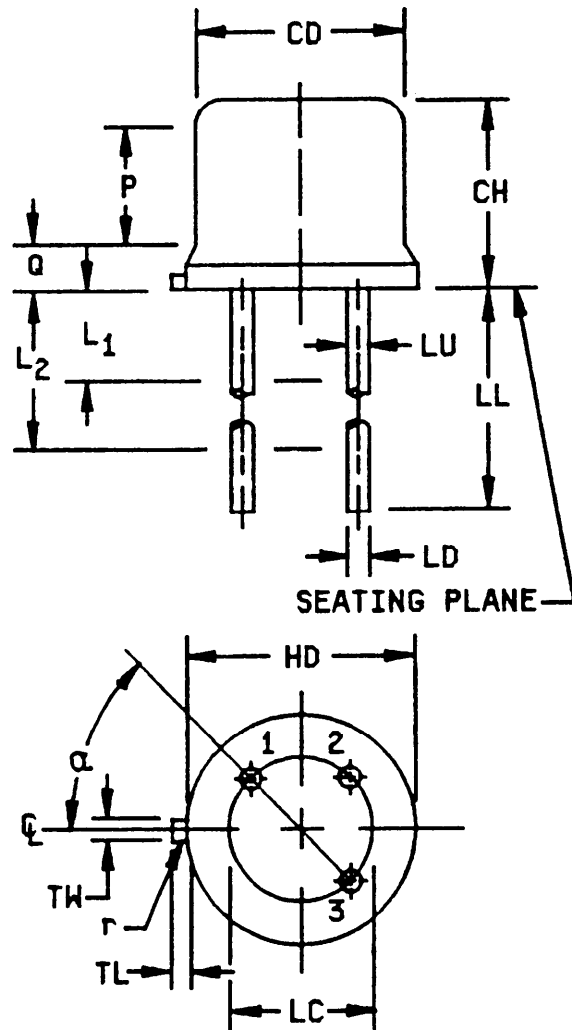


NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Symbol TL is measured from HD maximum.
4. Symbol CD shall not vary more than .010 inch (0.25 mm) in zone P. This zone is controlled for automatic handling.
5. Leads at gauge plane .054 inch (1.37 mm) +.001 inch (0.03 mm) -.000 inch (0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of TP relative to tab. Device may be measured by direct methods or by gauge.
6. Symbol LU applies between L₁ and L₂. Dimension LD applies between L₂ and LL minimum. Lead diameter shall not exceed .042 inch (1.07 mm) within L₁ and beyond LL minimum.
7. Lead 1 - emitter, lead 2 - base, lead 3 - collector.
8. Lead number three is electrically connected to case.
9. Beyond r maximum, TW shall be held for a minimum length of .011 inch (0.28 mm).
10. Symbol r applied to both inside corners of tab.
11. In accordance with ANSI Y14.5M, diameters are equivalent to ϕ x symbology.

FIGURE 1. Physical dimensions (type 2N4029).

Symbol	Inches		Millimeters		Note
	Min	Max	Min	Max	
CD	.305	.335	7.75	8.51	4
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	
LC	.200 TP		5.08 TP		5
LD	.016	.021	0.41	0.53	6
LL	.500	.750	12.70	19.05	
LU	.016	.019	0.41	0.48	6
L ₁		.050		1.27	6
L ₂	.250		6.35		6
TL	.029	.045	0.74	1.14	
TW	.028	.034	0.71	0.86	
P	.100		2.54		
Q		.050		1.27	
r		.010		0.18	10
α	45° TP		45° TP		



NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Symbol TL is measured from HD maximum.
4. Symbol CD shall not vary more than .010 inch (0.25 mm) in zone P. This zone is controlled for automatic handling.
5. Leads at gauge plane .054 inch (1.37 mm) +.001 inch (0.03 mm) -.000 inch (0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of TP relative to tab. Device may be measured by direct methods or by gauge.
6. Symbol LU applies between L₁ and L₂. Dimension LD applies between L₂ and LL minimum. Lead diameter shall not exceed .042 inch (1.07 mm) within L₁ and beyond LL minimum.
7. Lead 1 - emitter, lead 2 - base, lead 3 - collector.
8. Lead number three is electrically connected to case.
9. Beyond r maximum, TW shall be held for a minimum length of .011 inch (0.28 mm).
10. Symbol r applied to both inside corners of tab.
11. In accordance with ANSI Y14.5M, diameters are equivalent to ϕ x symbology.

FIGURE 2. Physical dimensions (type 2N4033).

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARDS

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Y14.5M - Dimensioning and Tolerancing. (Dod adopted)

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018-3308.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Associated detail specification. The individual item requirements shall be in accordance with MIL-S-19500 and as specified herein.

3.2 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-S-19500.

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in figure 1, (T0-18) for 2N4029 and figure 2, (T0-39) for 2N4033.

3.3.1 Lead finish. Lead finish shall be solderable in accordance with MIL-S-19500.

3.4 Marking. Marking shall be in accordance with MIL-S-19500. At the option of the manufacturer, marking of the country of origin may be omitted from the body of the transistor, but shall be retained on the initial container.

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection procedures shall be in accordance with MIL-S-19500, and as specified herein.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-S-19500.

4.3 Screening (JANS, JANTX, and JANTXV levels only). Screening shall be in accordance with table II of MIL-S-19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table II of MIL-S-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
9	hFE2 and ICB01	N/A
11	ICB01; hFE2; $\Delta ICB01 = 100\%$ initial value or 2 nA dc, whichever is greater; $\Delta hFE2 = 15\%$ change from initial value.	ICB01 and hFE2
12	See 4.3.1	See 4.3.1
13	Subgroups 2 & 3 of table I herein; $\Delta ICB01 = 100\%$ of initial value or 2 nA dc whichever is greater; $\Delta hFE2 = 15\%$ of initial value.	Subgroup 2 of table I herein; $\Delta ICB01 = 100\%$ of initial value or 2 nA dc, whichever is greater; $\Delta hFE2 = 15\%$ of initial value.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: T_A = Room ambient as defined in MIL-S-19500;

JANS - - - $V_{CB} = 10$ V dc; JANTX, JANTXV - - - $V_{CB} = 40$ V dc;
 2N4029 - - - $P_T = 0.5$ W
 2N4033 - - - $P_T = 0.8$ W

NOTE: No heat sink or forced air cooling on the devices shall be permitted.

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-19500, and table I herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table IVa (JANS) and IVb (JAN, JANTX, and JANTXV) of MIL-S-19500, and as follows. Electrical measurements (endpoints) shall be in accordance group A, subgroup 2 herein.

4.4.2.1 Group B inspection, table IVa (JANS) of MIL-S-19500.

Subgroup	Method	Condition
B4	1037	$V_{CB} = 40$ V dc; 2N4029 - $P_T = 0.5$ W; 2N4033 - $P_T = 0.8$ W; $T_A = +25^\circ\text{C} \pm 3^\circ\text{C}$; $t_{on} = t_{off} = 3$ minutes minimum for 2,000 cycles. No heat sink or forced-air cooling on devices shall be permitted.
B5	1027	$V_{CB} = 40$ V dc; $T_A = +125^\circ\text{C} \pm 25^\circ\text{C}$ for 96 hours, $P_T = 0.5$ W for 2N4029, 0.8 W for 2N4033, or adjusted as required by the chosen T_A to give an average lot $T_J = +275^\circ\text{C}$.
B5	2037	Test condition A (Au die interconnects only).
B6	3131	See 4.5.2.

4.4.2.1 Group B inspection, table IVB (JAN, JANTX, and JANTXV) of MIL-S-19500.

Subgroup	Method	Condition
B3	1027	$T_A = +30^\circ\text{C} \pm 5^\circ\text{C}$; $V_{CB} = 40\text{ V dc}$; $P_T = 0.5\text{ W}$ for 2N4029, 0.8 W for 2N4033; No heat sink or forced-air cooling on the devices shall be permitted.
B5	3131	See 4.5.2.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table V of MIL-S-19500, and as follows. Electrical measurements (endpoints) shall be in accordance group A, subgroup 2 herein.

Subgroup	Method	Condition
C2	2036	Test condition E.
C6	1026	$T_A = +30^\circ\text{C} \pm 5^\circ\text{C}$; $V_{CB} = 40\text{ V dc}$; $P_T = 0.5\text{ W}$ for 2N4029, 0.8 W for 2N4033; No cooling or forced-air cooling on the devices shall be permitted.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

4.5.2 Thermal resistance (to be performed for qualification inspection only). Thermal resistance measurements shall be conducted in accordance with method 3131 of MIL-STD-750. The following details shall apply:

- Collector current magnitude during power applications shall be .15 A dc.
- Collector to emitter voltage shall be 20 V dc.
- Reference temperature measuring point shall be the case.
- Reference point temperature shall be $25^\circ\text{C} \leq T_R \leq 35^\circ\text{C}$ and recorded before the test is started.
- Mounting arrangements shall be with heat sink to case.
- Maximum limit shall be $R_{\theta JC} = 17.5^\circ\text{C/W}$.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Breakdown voltage collector - emitter	3011	Bias condition D; I _C = 10 mA dc; pulsed (see 4.5.1)	V(BR)CEO	80		V dc
Breakdown voltage collector - base	3001	Bias condition D; I _C = 10 μA dc	V(BR)CBO	80		V dc
Breakdown voltage emitter - base	3026	Bias condition D; I _E = 10 μA dc	V(BR)EBO	5		V dc
Collector - base cutoff current	3036	Bias condition D; V _{CB} = 60 V dc	I _{CBO1}		10	nA dc
Collector - emitter cutoff current	3041	Bias condition A; V _{CE} = 60 V dc; V _{BE} = 2.0 V dc	I _{CEX1}		25	nA dc
Base - emitter cutoff current	3061	Bias condition D; V _{BE} = 3.0 V dc	I _{EBO}		25	nA dc
Forward - current transfer ratio	3076	V _{CE} = 5.0 V dc; I _C = 100 μA dc	h _{FE1}	50		
Forward - current transfer ratio	3076	V _{CE} = 5.0 V dc; I _C = 100 mA dc; pulsed (see 4.5.1)	h _{FE2}	100	300	
Forward - current transfer ratio	3076	V _{CE} = 5.0 V dc; I _C = 500 mA dc; pulsed (see 4.5.1)	h _{FE3}	70		
Forward - current transfer ratio	3076	V _{CE} = 5.0 V dc; I _C = 1.0 A dc; pulsed (see 4.5.1)	h _{FE4}	25		
Collector - emitter saturated voltage	3071	I _C = 500 mA dc; I _B = 15 mA dc; pulsed (see 4.5.1)	V _{CE(sat)1}		0.15	V dc
Collector - emitter saturated voltage	3071	I _C = 500 mA dc; I _B = 50 mA dc; pulsed (see 4.5.1)	V _{CE(sat)2}		0.50	V dc
Collector - emitter saturated voltage	3071	I _C = 1.0 A dc; I _B = 100 mA dc; pulsed (see 4.5.1)	V _{CE(sat)3}		1.0	V dc

See footnote at end of table.

TABLE 1. Group A inspection - continued.

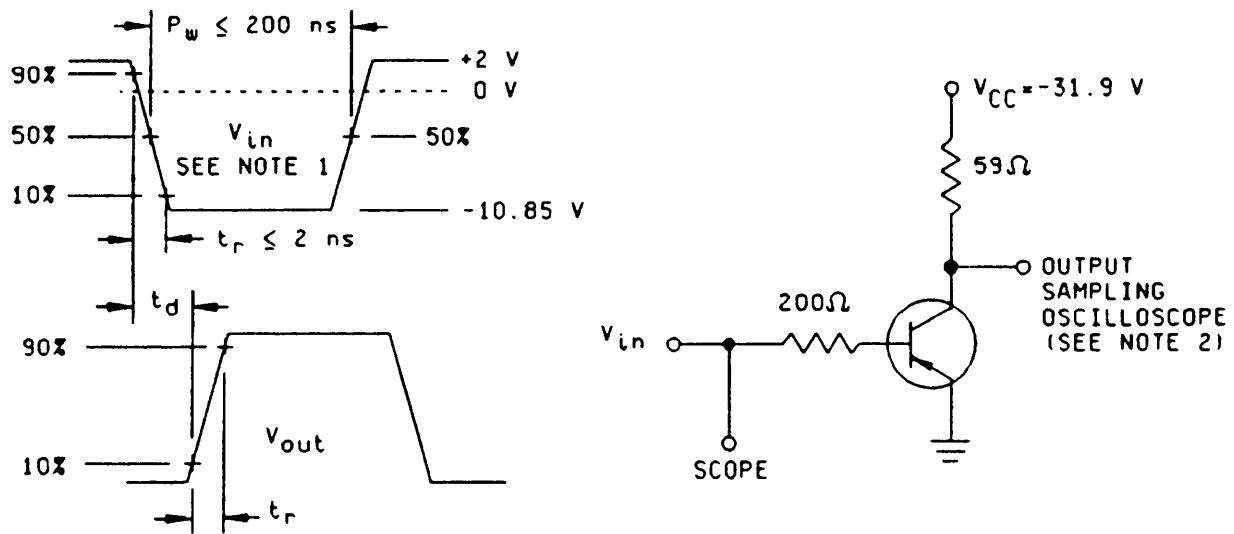
Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 2 - Cont.</u>						
Base - emitter saturated voltage	3066	Test condition A; $I_C = 150 \text{ mA dc}$; $I_B = 15 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{BE(sat)1}$		0.9	V dc
Base - emitter saturated voltage	3066	Test condition A; $I_C = 500 \text{ mA dc}$; $I_B = 50 \text{ mA dc}$; pulsed (see 4.5.1)	$V_{BE(sat)2}$		1.2	V dc
<u>Subgroup 3</u>						
High-temperature operation		$T_A = +150^\circ\text{C}$				
Collector - base cutoff current	3041	Bias condition D; $V_{CB} = 60 \text{ V dc}$	I_{CB02}		25	$\mu\text{A dc}$
Low - temperature operation		$T_A = -55^\circ\text{C}$				
Forward - current transfer ratio	3076	$V_{CE} = 5.0 \text{ V dc}$; $I_C = 500 \text{ mA dc}$; pulsed (see 4.5.1)	h_{FE5}	30		
<u>Subgroup 4</u>						
Magnitude of common emitter small-signal short-circuit forward-current transfer ratio	3306	$V_{CE} = 10 \text{ V dc}$; $I_C = 50 \text{ mA dc}$; $f = 100 \text{ MHz}$	$ h_{fe} $	1.5	6.0	
Open circuit output capacitance	3236	$V_{CB} = 10 \text{ V dc}$; $I_E = 0$; $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{ob0}		20	pF
Input capacitance (output open - circuited)	3240	$V_{EB} = 0.5 \text{ V dc}$; $I_C = 0$; $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	C_{ib0}		80	pF
Pulse response:						
Delay time	3251	Test condition A; $I_C = 500 \text{ mA dc}$; $I_{B1} = 50 \text{ mA dc}$; (see fig 3.)	t_d		15	ns
Rise time	3251	Test condition A; $I_C = 500 \text{ mA dc}$; $I_{B1} = 50 \text{ mA dc}$; (see fig. 3)	t_r		25	ns

See footnote at end of table.

TABLE 1. Group A inspection - continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 4 - cont.</u>						
Storage time	3251	Test condition A; I _C = 500 mA dc; I _{B1} = I _{B2} = 50 mA dc; (see fig. 4)	t _s		175	ns
Fall Time	3251	Test condition A; I _C = 500 mA dc; I _{B1} = I _{B2} = 50 mA dc; (see fig. 4)	t _f		35	ns
<u>Subgroups 5, 6 and 7</u>						
Not applicable						

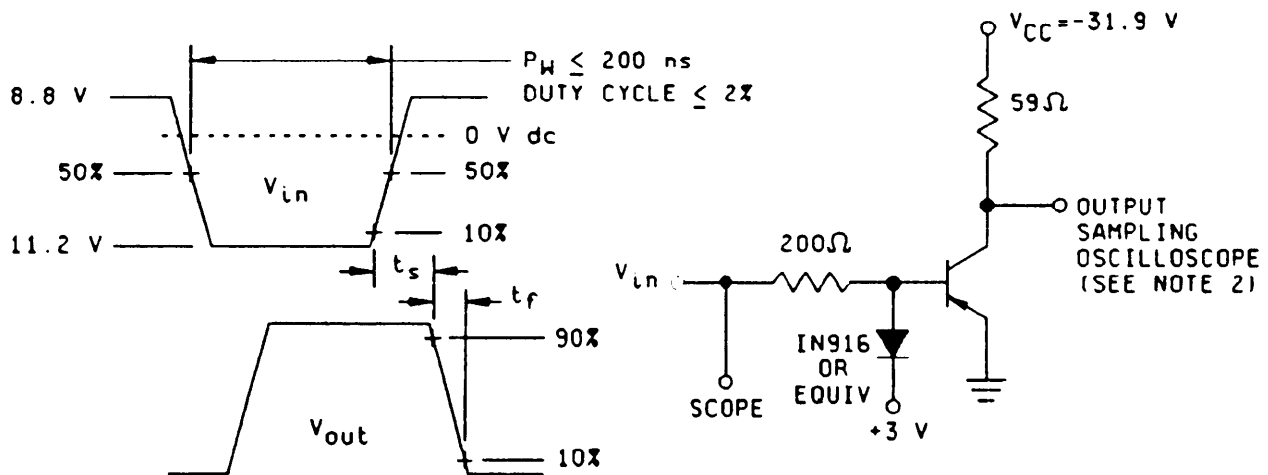
For sampling plan see MIL-S-19500.



NOTES:

1. The rise time (t_r) or applied pulse shall be ≤ 2 ns, duty cycle $\leq 2\%$ and the generator source impedance shall be 50 ohms.
2. Sampling oscilloscope: $Z_{in} \geq 100$ k Ω , $C_{in} \leq 12$ pF, rise time ≤ 5 ns.

FIGURE 3. Test circuit for measuring t_d and t_r times.



NOTES:

1. The rise time (t_r) or applied pulse shall be ≤ 2 ns, duty cycle $\leq 2\%$ and the generator source impedance shall be 50 ohms.
2. Sampling oscilloscope: $Z_{in} \geq 100$ k Ω , $C_{in} \leq 12$ pF, rise time ≤ 5 ns.

FIGURE 4. Test circuit for measuring t_s and t_f times.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Issue of DODISS to be cited in the solicitation.
- b. Lead finish (see 3.3.1).
- c. Type designation and quality product level.

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

CONCLUDING MATERIAL

Custodians:

Army - ER
Navy - EC
Air Force - 17
NASA - NA

Preparing activity:
NASA - NA

Agent:
DLA - ES

Review activities:

Army - AR, MI
Air Force - 85, 99
DLA - ES

(Project 5961-1494)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

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I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-S-19500/512B

2. DOCUMENT DATE (YYMMDD)
94/09/29

3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON SWITCHING TYPES 2N4029, 2N4033 JAN, JANTX, JANTXV, AND JANS

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle initial)

b. ORGANIZATION

c. ADDRESS (Include Zip Code)

d. TELEPHONE (Include Area Code)

7. DATE SUBMITTED
(YYMMDD)

(1) Commercial

(2) AUTOVON
(If applicable)

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(2) AUTOVON

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NASA Goddard Space Flight Center
Code 310.A
Greenbelt, MD 20771

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